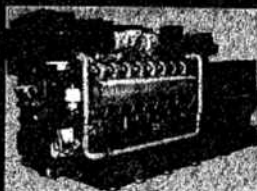


the DG Book

Guidelines for the Interconnection of Distributed
Generation to the ComEd System





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1. INTRODUCTION AND SCOPE

This guide is for customers or anyone else who is evaluating, planning, or operating generation in parallel with the ComEd system to provide electricity for the exclusive use of only a single entity. The term "customer" is used in these guidelines to refer to the owner/operator of parallel generation even if not technically a customer for ComEd's electric service. Parallel generation refers to but is not limited to distributed source generation, independent power producers, non-utility generators, off site generation and municipalities with generation.

This guide is not intended to replace "the Blue Book: Guidelines for the Interconnection of Generation to the ComEd System". It is intended for the interconnection of generation to ComEd's distribution system and the interconnection of small generators to ComEd's transmission system. For large generators connected to ComEd's transmission system "the Blue Book: Guidelines for the Interconnection of Generation to the ComEd System" should be used.

The principles contained in this guide are consistent with the Illinois Administrative Code in Title 83 Chapter I Section 430.40, subparagraph e.

"The qualifying facility shall furnish, install, operate, and maintain in good order and repair and without cost to the utility such relays, locks and seals, breakers, automatic synchronizer and other control and protective apparatus as specified and approved by the utility as necessary for the operation of the qualifying facility in parallel with the utility's system and to permit the utility's facilities to operate in a normal manner. The utility shall have the right to specify, approve, establish minimum standards for, or require advance consultation on any or all of the above equipment."



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2. SUMMARY OF NON-RESIDENTIAL RATES

ComEd's various rates and riders each contain its applicable conditions of service as well as its charges. Since ComEd's rates and riders are subject to change, the following summary of their general nature of service is presented as a guideline. For specific information a ComEd representative, such as an Account Manager, should be contacted.

GENERAL SERVICE: ComEd has several nonresidential general service rates, and the applicable rate is governed by the customer's billing demand. These rates are:

- General Service, Non Time of Day
- Optional General Service, Time of Day
- General Service, Time of Day
- Large General Service, Time of Day

SPECIAL USE: ComEd's principal special use rates and riders are for:

- Water-Supply and Sewage Pumping Service
- Electric Space Heating Service

Retail Services Requirements

Standby Service

Customers who have installed their own electric generating facilities which are used exclusively to produce all or a portion of the customer's electrical power and energy requirements on a regular basis, and who wish to use ComEd's electric service as a standby, auxiliary, or reserve service may be served under a specific standby rate.

Interruptible or Curtailable Service

Customers who are able to interrupt or curtail their electricity purchases from ComEd upon ComEd's request are eligible for billing credits or reduced charges through the following riders:

- Interruptible / Curtailable Service
- Curtailable Service Cooperative

Experimental Programs

In addition to the above rates and riders, ComEd may, from time to time, offer service in accordance with experimental programs pursuant to Section 16-106 of the Electric Service Customer Choice and Rate Relief Law of 1997 (220 ILCS 5/16-106). Please contact a ComEd account representative for specific information.

2. SUMMARY OF NON-RESIDENTIAL RATES (continued)

Delivery Services Tariffs

ComEd's Delivery services tariff is available for customers who are eligible for, and elect to have ComEd deliver electric power and energy on an unbundled basis. This tariff provides for the delivery of unbundled electric power and energy. Customers with generators that elect to receive their supply of electricity from an entity other than ComEd should refer to this tariff.

Retail Customer Delivery Service

- Provides for the delivery of electric power and energy sold to retail customers by Retail Electric Suppliers (RES's) taking service under ComEd's Retail Electric Supplier Service rate.
- Provides for the delivery of electric power and energy to Customer Self-Managers
- Provides for the delivery of electric power and energy sold to retail customers by the company under the Company's Power Purchase Option (Rider PPO) or Interim Supply Service (Rider ISS).

Tariffs associated with Retail Customer Delivery Service

Although there are a large number of tariffs that apply to ComEd's delivery services tariff, the following is a list of those tariffs that are generally considered to be closely associated with delivery services:

- Customer Transition Charge
- Power Purchase Option
- Interim Supply Service
- Retail Electric Supplier Service
- Single Bill Option
- Partial Requirements Contract Service
- Metering Service Provider Service

Customers seeking additional information regarding delivery services tariffs should contact a ComEd representative. Names can be found on our website at <http://www.comedtransmission.com>.

Transmission Tariffs

At the time of this publication, ComEd has in place an Open Access Transmission Tariff (OATT). ComEd's OATT can be obtained through the internet at <http://www.comedtransmission.com>. ComEd has joined the Alliance Regional Transmission Organization (ARTO) which was approved by the FERC on December 20, 1999. A preliminary ARTO tariff has been filed with FERC. The FERC-approved tariff will become effective when the ARTO becomes operational. This is expected to occur in the year 2001. These tariffs contain the rates for transmission services, including rates for the ancillary transmission services offered by ComEd.



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2. SUMMARY OF NON-RESIDENTIAL RATES (continued)

Billing and Payment Terms

Customers shall reimburse ComEd for all interconnection costs incurred by ComEd, according to ComEd's policies and procedures. From time to time, the customer may be charged additional charges associated with the upkeep and maintenance of the interconnection.

Customers who have their own Generated Electricity Flow into the ComEd system: ComEd will accept power which flows from the customer into ComEd as outlined below. If there is no energy purchase contract, ComEd will not pay for or reimburse for such flow of energy.

Qualifying Facility: If the customer's generation is a Qualifying Facility under PURPA, ComEd will purchase such energy at avoided cost, provided the customer signs such a contract in advance of the energy flow.

Qualified Solid Waste Energy Facility: If the customer's generation is certified as a Qualified Solid Waste Energy Facility by the Illinois Commerce Commission, ComEd will purchase such energy at the amount prescribed by law, provided the customer signs such a contract in advance of the energy flow.

Non-Qualifying Facility: If the customer's generation is not certified as a Qualified Facility by the Federal Energy Regulating Commission (FERC), ComEd will not provide compensation for such flow of energy.

3. PLANNING FOR PARALLEL OPERATION

The Process

This section outlines the steps required to take a customer's project from issuance of the initial paperwork to completion of the project. It is provided to familiarize the customer with the different ComEd departments that will be involved and their activities. A detailed discussion of the process follows. A flow diagram of the process is shown on page 7.

After initial meetings with the Account Manager, Customer Project Management, and Engineering Department(s), the customer will submit to ComEd the necessary information concerning the generation installation. Refer to Appendix 1 for some of the information necessary at this point. When the ComEd Account Manager has received all required data from the customer, a Service Estimate Request (SER) will be issued to the Distribution Planning Department and to the Substation Engineering Department. ComEd will then perform an engineering analysis. Distribution Planning is responsible for determining which ComEd line(s) the customer will be connected to. That decision is based on the customer's generating capability, line availability, and line location. In cases where a minimum of Plan B protection is called for, Customer Project Management will require a deposit to cover the costs of the required interconnect study. The amount of the deposit will be based on the estimate of engineering costs necessary to arrive at an interconnect cost for the customer's proposed system. If the customer chooses to abandon or materially change the scope of the project after being presented with the costs to interconnect, the unspent portion of the deposit (if any) shall be refunded to the customer. Should the customer wish to proceed with the project after being presented with interconnect costs and requirements, the amount of the deposit shall be deducted from the total interconnect cost. Once the Account Manager has received the deposit, Distribution Planning will issue a project diagram (PD) to other concerned ComEd departments including the Relay and Protection Services Group.

Upon receipt of the PD, the Relay and Protection Services Group will determine the relay requirements necessary for the protection of the ComEd system. Upon completion of this analysis, Relay and Protection Services will submit their relay notes, requirements, and an estimate of the relay costs to Distribution Planning to be added to the final project diagram. Relay and Protection Services will copy this information to Substation Engineering, and to Customer Project Management. Relay and Protection Services will also issue a required relay equipment Bill of Material to the Project Engineer. At this time, Customer Project Management may require the customer to authorize the purchase of any long lead-time material identified by ComEd System Protection and Substation engineering.

3. PLANNING FOR PARALLEL OPERATION (continued)

The Substation Project Engineer then becomes the focal point of the project. The Substation Project Engineer will take the information received and develop an interconnection design. A Service Entrance Location Sketch (supplied by a distribution customer project engineer when applicable), which will detail both the customer's and ComEd's responsibilities under the proposed parallel operation, will be issued. At the same time, the SER Reply will be issued detailing all ComEd charges to the customer. Both of these documents will be submitted by the Account Manager to the customer for approval. Approval of the ComEd Service Entrance Location Sketch is the customer's signature on the sketch agreeing to the engineering and operating requirements of the installation. Upon receipt of approval and payment from the customer, the Account Manager will issue authorization to the Project Engineer to complete the final engineering and issue the necessary work orders to the ComEd construction departments.

The time frame between issuance of the SER to issuance of the work orders varies and is dependent upon the access and availability of information. A realistic time frame will be provided when the Project Engineer has analyzed all the information received. The Customer Project Manager will assemble a project team made up of representatives from each of the ComEd departments which will take part in completing the project. A construction timetable will be established, and in conjunction with the customer and his representative, the project will move towards completion within a time frame mutually agreed to by ComEd and the customer at one of the engineering project review meetings.

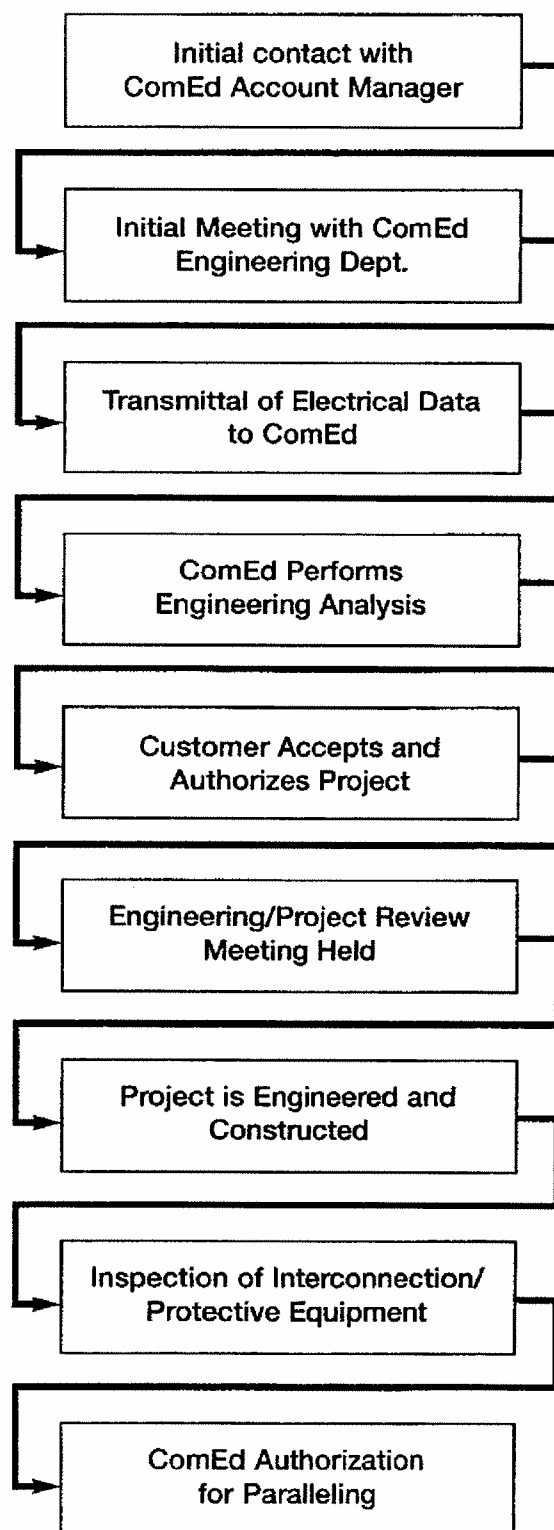
Before the project is completed, the Relay and Protection Services Group will review and approve the customer's final design documents which apply to protection of the ComEd system associated not only with the generation interface but also customer protection on equipment at the interface. Any relays used to protect the ComEd system must be approved for that application. Relays not already approved for use on the ComEd system may have to be tested at the customer's expense. A partial list of approved relays is included in Appendix 7.

Settings on the protection will also be reviewed and approved by the Relay and Protection Services Group. There will also be an inspection of the interconnection and protection equipment before parallel performed by the Relay and Protection Services Group.

At this point ComEd will authorize the generation installation for paralleling with the ComEd system.

3. PLANNING FOR PARALLEL OPERATION (continued)

Process Flow - Paralleling to the ComEd System



3. PLANNING FOR PARALLEL OPERATION (continued)

Process Details

Initial Discussions

Customers are encouraged to discuss plans with their ComEd Account Manager early in the design stage before developing final prints or ordering equipment. This could help to avoid unnecessary or unforeseen costs involving the generator's connections, interface connections, or ComEd system changes or scheduling concerns.

The initial electrical configuration/design for parallel generation can be greatly affected by ComEd system connections to the customer as well as the overall system voltage and circuits in the vicinity. For example, there may be other generators on the existing ComEd circuits. Additional generation can cause stability problems or unacceptably high fault currents, thereby exceeding customer and ComEd equipment fault interrupting capability. Also, the existing ComEd supply may be from a low voltage network which is not compatible with generation.

Early discussions with ComEd are also recommended to determine what elements of the project may require substantial lead times. Such lead times can be attributed to the acquisition and installation of new protective devices or system reconfiguration necessary before parallel operation can be safely allowed. Refer to Appendix 1 "Generator and Step-Up Transformer Data Sheets."

Preliminary Estimates of Interface Requirements

If a customer desires preliminary cost estimates to evaluate the installation of parallel generation, possibly with alternatives, ComEd will require information outlined in Appendix 1 covering various technical information in regards to the customer's generator(s) and proposed interconnection to the ComEd system. Based on the information submitted, ComEd will provide a preliminary estimate of costs for parallel operation and initial connection and any protection concerns. It should be kept in mind that final costs and specifications, based on a fully detailed analysis, may be different.

ComEd Engineering Analysis

If the customer ultimately decides to install generating equipment, confirmation of the data previously supplied for feasibility and any additional related information deemed appropriate for the particular design will be required. Upon receipt of the required information, ComEd will determine the requirements for the ComEd/customer interconnection, including protective relay requirements.

ComEd's functional relay requirements based on the initial information will be given to the customer by the ComEd Customer Project Management. The ComEd forms used for this purpose are called the Relay Functional Requirements Specifications (RFRS) and the Preliminary Relay Requirements Diagram. Sample copies of these forms for four general protective schemes are included as part of Appendices 2, 3, 4, and 5 of these guidelines.

3. PLANNING FOR PARALLEL OPERATION (continued)

The RFRS forms for a specific project show the protective functions for which the customer is to provide relays and related equipment. The customer must indicate on the RFRS form the specific relay type and range proposed for each function. The customer must also provide proposed current and potential transformer ratios, connections and locations as related to the electrical one-line schematic diagram. The completed RFRS forms and related information are to be returned to the ComEd Account Manager.

Engineering/Project Review Meeting(s)

The ComEd Account Manager will arrange for meetings, as required, between ComEd engineers and the customer (including the customer's engineer and/or consultants) to discuss the functional relay requirements and/or other appropriate topics.

4. ENGINEERING FOR PARALLEL OPERATIONS

Revenue Metering Requirements

The basic configuration consists of bi-directional metering (in & out) at the point of inter-connection with ComEd. In addition, the gross output of the generator/generators is metered for certain Rates. This allows for the measurement of energy received and delivered by ComEd, as required by the applicable Rates.

All metering equipment used must comply with the latest edition of the Information and Requirements for the Supply of Electric Service. Section VI and the applicable specification sections cover metering. The System Meter Department issues a number of guides (MDGs) that cover meter requirements also. MDG-1 addresses metering specifications for 2400 volt to 13,200 volt installations. For voltages above 13,200 volts, the System Meter Department will provide job specific requirements. MDG-7 addresses requirements for pulse output from the ComEd meters, if so desired by the customer.

All jobs require review and approval by the System Meter Department of manufacturer's switchgear drawings showing overall electrical one-lines, physical construction and equipment layout of the metering sections.

Telemetry Requirements

Some generators will require telemetry to ComEd operation facilities. These will typically be large generators, or generators which are dispatchable by ComEd. Telemetry may be required for one or more of the following reasons.

1. System Control - ComEd has an obligation to maintain frequency and generation/load balance within its service territory. Changes in the status of large amounts of generation, without real-time telemetry, is detrimental to system control.
2. Monitor Wholesale Power Transaction - ComEd must be able to monitor wholesale power transactions taking place between generators and third parties through the ComEd system.
3. Transmission and Distribution System Operation - The status of large generators will have a significant impact on operating decisions. Operators will need to know the status of these large generators prior to performing routine or emergency switching.
4. Public Safety - Generators can potentially keep a portion of the electrical grid energized while isolated from the ComEd system. It is critical to detect these situations as soon as they occur so that corrective action can be taken since safety of the public and ComEd workers is at stake.

4. ENGINEERING FOR PARALLEL OPERATIONS (continued)

Generators which meet the following criteria will require the implementation of telemetry to ComEd's control center. The required telemetry is listed below each criterion. If a generator falls into more than one criterion, the telemetry requirements of each criterion must be met.

1. If the aggregate generation at a site is greater than 10MW and also greater than 50% of the peak load at the site, or if the generation is being sold to the wholesale market.
 - Continuous telemetry required.
 - Instantaneous MW and MVar of each generator larger than 10MW.
 - Instantaneous MW and MVar at all points of service from ComEd.
 - Status of all circuit breaker(s) which can disconnect a generator from the ComEd system.
 - Status of bus tie circuit breaker(s).
 - At least one bus kV measurement.
 - Cumulative revenue grade MWhr and MVarhr as required by applicable rates and power purchase agreements. This may include only ComEd point(s) of service, or it may include all generators.
 - Remote trip control of circuit breakers at all points of service from ComEd.
 - If ComEd purchases automatic generation control (AGC) services, additional information to implement that service must be exchanged between ComEd and the generator.
2. If the generation will be remotely turned on or off by ComEd.
 - Continuous telemetry required.
 - Instantaneous MW.
 - Supervisory control for generator on/off from ComEd.
3. If multiple generators over a large area are being centrally controlled with an aggregate generation greater than 40MW.
 - Continuous telemetry required.
 - Instantaneous MW of each generator or aggregate instantaneous MW of all generators.
4. If the generation, for protection, requires transfer trip communication, then transfer trip communication status shall be telemetered. Remote control to disable transfer trip shall also be provided.

Details of the specific telemetry requirements will be provided at the initial project meeting with ComEd.

The generator owner shall be responsible for the installation cost and monthly communication costs of the required telemetry.

4. ENGINEERING FOR PARALLEL OPERATIONS (continued)

Stability Studies

Severe disturbances on the power system can potentially cause a synchronous generator to lose synchronism with the power system. A large generator operating in this unstable manner can create large power and voltage fluctuations, and can severely stress the generator and power system equipment. Damage could result to customer equipment and the ComEd System. The resulting disturbances may affect other customers as well. Based on accepted industry protection guidelines, out-of-step protection is required to address stability concerns.

The following procedures will be used to insure that the interconnection design provides for an adequate stability margin.

The customer shall provide data pertaining to the generator and related control systems that are required for the stability analysis. Forms for this data appear in Appendix I.

For type A, B, and C interconnection configurations, ComEd will review the generator data and preliminary design and determine if any special stability studies are required.

For type D interconnection configurations:

- ComEd will perform stability analysis in order to verify that the generator installation meets the ComEd criteria. In this criterion, the most severe fault that could credibly occur near the generator will be analyzed. Typically this will be a three-phase fault followed by a circuit breaker failure, although this scenario may vary depending on specific details of the installation. If the generator loses synchronism for this scenario, special generator protection will be required in addition to out-of-step protection of the generator. If the generator does not lose synchronism for this scenario, then out-of-step protection will be sufficient.
- ComEd will complete the initial stability analysis of the interconnection and will identify any special stability protection schemes (in addition to out-of-step protection) which are required for the interconnection design. These may include such schemes as high speed stability trip schemes on the transmission lines and special communication channels from remote terminals indicating circuit breaker and disconnect switch status.
- The following information will be identified by these stability studies.
 - a) The critical clearing time for 3-phase faults on each line connected to the generator.
 - b) The critical clearing time for the most severe 3-phase fault/Circuit Breaker failure combination related to the interconnection.
 - c) A summary of special stability protection schemes, in addition to out-of-step protection, which are required for the interconnection.

Stability analysis performed by ComEd will not evaluate the risk to the customer's equipment due to unstable operation of its own generator. It is the responsibility of the customer to assess these risks and protect accordingly.

If subsequent generation is added to the ComEd system near the customer's interconnection, it is the customer's responsibility to assess the risks of these changes. If necessary, ComEd will re-verify that the generator installation meets ComEd requirements. It may be determined at this point that additional protection will be required at the customer's expense.

4. ENGINEERING FOR PARALLEL OPERATIONS (continued)

Approval of Final Customer Prints

Before proceeding with construction, the customer must furnish six sets of final design documents to ComEd for review and approval. These must be of good engineering quality and include the following:

- One line diagram showing the connections between the generator(s) and the ComEd system
- Three line diagrams showing current and potential circuits for protective relays
- Relay tripping and control schematic diagram
- Instruction books for relays on the Relay Functional Requirements Specifications (RFRS)

Additional engineering meetings may be necessary to discuss the design documents. If changes are necessary, the customer must incorporate all changes and corrections and submit six sets of corrected prints to ComEd before proceeding with construction. The ComEd Account Manager will inform the customer when all required approvals are received.

ComEd will approve only those portions of drawings that apply to protecting the ComEd system. ComEd may comment on other areas which appear to be incorrect or deficient; however, the customer is responsible for the design of protection which involves only the customer's facilities.

Approval of Customer Relays and Settings

Any relays used by the customer to protect the ComEd system must be approved for that application. Relays not already approved for use on the ComEd system may have to be tested at the customer's expense. A partial list of approved relays is included in Appendix 9. The customer must also furnish for ComEd approval proposed settings for relays specified on the RFRS. If requested, ComEd will provide system data needed to determine the relay settings.

Inspection of Installation

Before parallel operation with the ComEd system, the installation must be witnessed and inspected by ComEd (Testing Group). This will include:

- The acceptance testing of all relays according to ComEd minimum requirements
- The placement of in-service relay taps according to settings
- The operability of the protective equipment including relays, circuit breakers and communication channels
- The phasing and synchronizing checks of all related equipment.

Please refer to Appendix 7 for specific Pre-Interconnect Inspection Standards.

The customer must notify ComEd (Account Manager) at least ten business days prior to the day of relay and equipment testing. Updated blueprints (as-builts) must be provided to ComEd (Account Manager) for verification at least seven business days prior to the day of parallel operation. Final approval of the completed installation by ComEd (Testing Group and Power Supply) is required before parallel operation may begin. ComEd (Testing Group) must witness the initial paralleling.



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4. ENGINEERING FOR PARALLEL OPERATIONS (continued)

Periodic Test Data During Operation

The customer must provide ComEd with calibration and functional test data for the associated equipment at the intervals described below.

- | | |
|--------------------------|------------------------------|
| • Relays | Every three years |
| • Communication Channels | Every three years |
| • Circuit Breakers | Every three years |
| • Batteries | Per IEEE 450 - 1995 Standard |

The customer must include the identity and qualifications of the personnel who performed the tests. ComEd (Testing Group) may periodically witness the testing.

Data should be mailed to the following address:

ComEd
Relay and Protection Services
Attn: MAE
Two Lincoln Centre
Oakbrook Terrace, Illinois 60181-4260

5. PHILOSOPHY OF REQUIRED PROTECTION

General

General Need for System Protection in the Presence of Parallel Generation

The components of the T&D system are subject to a variety of natural and man-made hazards, among these are lightning, wind, wildlife and vandalism. Damaged or short-circuited equipment should be switched out of service as soon as possible to minimize safety hazards and to avoid additional equipment damage.

Generation operated in parallel with the T&D system provides an additional source of energy which must also be disconnected in case of an emergency. Because parallel generation may interfere with the operation of protective devices normally used by the T&D system, it is essential that a suitable system of protection be used to minimize hazards and to prevent the reduction of quality of service to other T&D customers.

General Effects of Parallel Generation on System Protection Requirements

The addition of generation shall not introduce a hazard or adversely affect the quality of service to ComEd customers.

Protective equipment must be added to standard ComEd facilities to provide adequate protection of the T&D system.

Requirements for additional protective equipment due to parallel operation will vary depending on the size of the customer's generation and load and on the nature of the ComEd local distribution system. The requirements range from a simple protection system, if the generator is small and if energy is always intended to be delivered from the ComEd system to the customer, to complex high speed schemes for larger generators.

The ComEd Relay & Protection Services Department will specify all necessary relaying, communication, and telemetry requirements for an interconnection.

Examples of general relay requirements for various types of installations are discussed in following sections.

5. PHILOSOPHY OF REQUIRED PROTECTION (continued)

Reclosing of Comed Supply Lines

Role of Automatic Reclosing

Most faults on an overhead transmission or distribution line are transient in nature. That is, if the line is de-energized promptly, it can be reclosed and returned to service. Examples of such transient faults include momentary tree contact due to wind and insulator flashover due to lightning. Automatic reclosing of overhead lines is standard industry practice to improve the reliability of supply. In many cases, the line can be de-energized and reclosed within one second with minimum disruption of service to the customers.

Effects of Parallel Generation on Automatic Reclosing

Automatic reclosing, however, presents a potential for damage to generating equipment operated in parallel with the utility. Severe mechanical stress on the customer's equipment may occur if the supply line is reclosed while the generator is still connected to the customer's system. This is true for both synchronous and induction generators. This applies to synchronous generators because they would be out of synchronism when the utility supply is restored. For induction generators, damage may also occur if they are operating at a speed higher or lower than normal when reclosed to the utility system. Reclosing under these conditions can also cause potential hazard or damage to ComEd facilities or other customers.

Addition of generation to a line shall not alter standard autorestitution schemes at transmission substations, distribution centers or other distribution loads. Some configurations will require direct tripping of connected generation for line faults.

This situation is not limited to automatic reclosing of the line which directly supplies the customer. For some system conditions, automatic reclosing of transmission or sub-transmission lines (which are part of radial supply to the customer) may result in the same type of situation.

As a general philosophy, ComEd will not eliminate automatic reclosing of overhead supply lines because that would severely reduce the reliability of service to other customers.

5. PHILOSOPHY OF REQUIRED PROTECTION (continued)

Possible Reclosing Scenarios and Customer Responsibilities

ComEd routinely performs maintenance on its system. While ComEd tries to perform all maintenance on a scheduled basis, there are times when emergency maintenance is necessary. In both instances, the work is generally planned to minimize both customer inconvenience and company cost. As a prudent cost control, ComEd schedules most routine maintenance during the normal daylight working hours. To this end, ComEd routinely transfers customer load among electric sources, so that the involved customers remain in service while the maintenance work is being performed. For most customers involved this "switching" is transparent.

However, there are situations when there can be no load transfer because a customer is operating a generator in parallel with the electric system. In non-emergency situations, possible courses of action may include:

- The customer may choose to turn off the generation and continue electric consumption. Electricity may be purchased from ComEd under the provisions of the Standby Service Rate.
- The customer may choose to turn off the generation while curtailing electric consumption. Electricity may also be purchased from ComEd under the provisions of the Standby Service Rate.
- The customer may request ComEd to perform the work at times when the customer's generation is not being operated. In such case the customer is responsible for, and will be billed for, the full extra cost that ComEd experiences due to the request. (83 Illinois Administrative Code, paragraph 430.30, definition of "Costs of interconnection.")
- Switch the customer's generation and load away from the utility system while the work is in progress. This option is only available if the customer's electric system can operate independently from the utility.

Notwithstanding the above, switching equipment capable of isolating the customer's generation from ComEd shall be accessible to and under the exclusive control of ComEd at all times. At its option, ComEd may choose to operate the switching equipment if, in ComEd's sole opinion, continued operation of the customer's generation in connection with the ComEd's system may create or contribute to a system emergency, an unsafe condition or interference with the service to other customers. [paraphrased from 83 Illinois Administrative Code paragraph 430.40(f) & (g)]

The switching equipment referred to above must be accessible to and capable of being operated and locked by ComEd personnel. This equipment must provide a visible break in the circuit.

5. PHILOSOPHY OF REQUIRED PROTECTION (continued)

Changes to the ComEd System

The ComEd system is constantly changing due to shifts in loading and the addition or removal of generation. The possibility exists that a change in the ComEd system may cause a change in the protection requirements at the generation interconnection. It would then be the responsibility of the generator owner to make the necessary changes to meet ComEd requirements.

Switching to Alternative ComEd Supply Lines

If the customer's generator may be switched to a different ComEd T&D line, then it becomes more difficult to provide adequate protection. Switching a section of the distribution system from one supply line to another is routinely done for temporary operation to facilitate maintenance or construction. Permanent transfer to a new normal supply is also done in conjunction with the installation of new facilities. For some customers, automatic switching equipment (ATO) may be used to transfer from the normal supply line to an alternate line.

The basic philosophy for all such conditions is to avoid hazardous or potentially damaging situations. Problems are more likely with large installations or where special facilities are required in connection with reclosing of ComEd supply lines. In most cases, it will be necessary for the customer to discontinue parallel operation if the normal supply line is out of service.

Use of automatic transfer (ATO) should generally be avoided for customers with parallel generation. If used, it will usually be necessary to modify the ATO control equipment to discontinue parallel operation (e.g., open the generator breaker) before the supply is transferred.

Supply from the Low Voltage Network

Parallel generator operation will not be allowed if the ComEd supply is from a low voltage network center or from a line that supplies network centers.

5. PHILOSOPHY OF REQUIRED PROTECTION (continued)

Momentary Parallel with ComEd only During Transfer

The required protection and switching will be evaluated individually for each situation where the customer's generating equipment is intended to be operated in parallel with the ComEd system only for short periods of time (generally less than one minute). The need for special protection will depend on factors such as the size of the customer's generation and load, the desired duration of parallel operation and the nature of ComEd supply facilities. The momentary parallel operation will be supervised by a hard-wired timing relay or equivalent interlocking scheme.

Protective Device Numbering

The following requirements and examples, the nomenclature and numbering of protective devices will follow the standards set forth in ANSI C37.2. This standard numbering should also be used by the customer on information provided to ComEd showing customer equipment.

A few of the more commonly used devices are shown in the following list:

2	Timer
4	Master Contactor
21	Distance Relay
25	Synchronizing or Synchronism Check
27	Under-voltage
32	Power Direction
40	Loss of Field Detection
46	Current Balance
47	Voltage Phase Sequence
50FD	Phase Instantaneous Over-current Fault Detector
51	Time Over-current
51G	Ground Time Over-current
51N	Neutral Time Over-current
51V	Voltage Restrained/Controlled Time Overcurrent
59	Overvoltage
59G	Overvoltage Type Ground Detector
67V	Voltage Restrained/Controlled Directional Time Overcurrent
79	Reclosing Relay
81O	Over-frequency
81U	Under-frequency
87	Current Differential

5. PHILOSOPHY OF REQUIRED PROTECTION (continued)

Generating Capacity Under 25kVA

Special protective devices on the ComEd system are generally not required for installations with a total generating capacity less than 25kVA, however an analysis needs to be performed for all generators added to the Transmission and Distribution system. These facilities must have suitable protection and provide an accessible disconnect switch that is lockable and has a visible break that ComEd can operate in order to isolate the generator from the ComEd system for maintenance, reliability, and safety concerns. In addition, applicable generators up to 40 kW derived from energy sources such as Wind and Photovoltaics (PV) shall be installed in accordance with current IEEE 929 standards and be UL 1741-listed using utility interactive (non-islanding) inverters with non adjustable setpoints.

For these installations, special protective devices are not required where the total generating capacity is less than 50 KVA on the ComEd feeder. Refer to Appendix 6 for the Wind/Photovoltaic Generator Application approval form.

Plan A

Requirements for Plan A Designation

Relatively small generators (25-2500 kVA) operated in parallel with the ComEd distribution system usually require adding relatively simple protective systems unless the minimum total load on the ComEd supply line is lower than twice the rating of the generator. In this case, a Plan B protection scheme is more appropriate. A Plan B protection scheme also might be required when multiple generation installations are on the same ComEd supply line.

Highlighted Protective Relay Functions

When a fault occurs on the system, ComEd quickly isolates the faulted line or equipment from the ComEd system. Because of the large imbalance between load and generation, voltage and frequency relays at the paralleled generator will detect these faults after the main terminal of the line has opened. Likewise, the voltage and frequency relays should detect and trip the unit for other islanding conditions where the generator becomes isolated with a system load that is at least twice the rating of the generator. Furthermore, to provide safe and proper closing of breakers when a generator is to be paralleled to the ComEd system, synchronizing relays may be required. All the protective relay requirements for Plan A are detailed in Appendix 2.

5. PHILOSOPHY OF REQUIRED PROTECTION (continued)

Plan B

Requirements for Plan B Designation

Medium-sized generators (2,500-10,000 kVA) can supply relatively large amounts of energy to the point of fault; therefore, additional protective functions are required. A generator connected to a ComEd supply line with a minimum line load less than twice the rating of the generator also stands a very good chance of islanding after the main terminal breaker opens with or without the fault remaining on the line. There are also instances where special system constraints may require using this plan. If there are multiple generators on a single ComEd supply line, a Plan C protection scheme may be required instead of a Plan B.

Highlighted Protective Relaying Functions

A point of fault electrical arc will not be extinguished until the line circuit breaker and the generator are tripped, totally de-energizing the line. Automatic reclosing of the source circuit breaker will not be able to restore service unless the arc is extinguished. For these reasons, phase and ground fault detecting relays, in addition to voltage and frequency relays, are required at the generator point of interconnection. Voltage supervision of automatic reclosing and synchronism check supervision of manual closing is required for the ComEd circuit breaker at the line source to minimize the risks of equipment damage and personal injury should an attempt be made to close the source circuit breaker with the generator still on line. If the power transformer at the interconnection is delta-connected on the ComEd supply, then a single phase-to-ground fault will not draw fault current once the line circuit breaker opens; however, the system will be over-voltaged. To prevent this from happening, voltage sensing on the ComEd supply side of the power transformer is required. The rest of the protective relay requirements for Plan B are detailed in Appendix 3.

Plan C

Requirements for Plan C Designation

High-speed protection of transmission lines is essential to maintain system stability and insure the integrity of the transmission system. Likewise, large generators (greater than 10MVA) can deliver very large amounts of energy to a fault. The level of protection increases under these conditions. There are also instances where special system constraints may require using this plan. The presence of multiple generation installations on a single ComEd transmission line may require Plan D protection. There may also be stability concerns.

Highlighted Protective Relay Functions

All sources connected to a transmission line, 69kV and above, are designed to open within 0.1 second for faults anywhere on the line. Line transfer trip (i.e., high speed communication) is required to fulfill this requirement for customer generation. Transfer trip is required to trip the generator for any islanding conditions. Transfer trip is also required if the generator is approximately 10 MVA or greater and connected to the 34kV and 12kV system. Plan C provides the facilities needed for high-speed transfer trip. To insure high-speed operation, a distance relay with no intentional time delay is usually required. To prevent excessive tripping, the voltage sensing for this distance relay must be on the ComEd supply side of the power transformer. The rest of the protective relay requirements for Plan C are detailed in Appendix 4.

5. PHILOSOPHY OF REQUIRED PROTECTION (continued)

Plan D

Requirements for Plan D Designation

Plan D is required for generators 10 MVA or greater connected to the ComEd transmission system at a voltage level below 345 kV. Plan D requires a level of protection at the generating site similar to that at the other terminals to the ComEd System.

Adding a terminal to a transmission line can compromise and degrade line protection. Where any compromises in protection occur, as determined by ComEd, a Plan E will be required. These installations are often merchant plants that sell their output on the wholesale market and are referred to as Independent Power Producers (IPP's). The Plan E requirements are presented in the Blue Book.

For these installations, redundancy of protection is required as NERC Planning Standards and MAIN guides which specify that no single protection system component failure can cause a fault to remain uncleared from a system.

Highlighted Protective Relay Functions and Other Plan Features

Because of the probability of islanding and the level of available fault energy, it is required that the customer's facilities be treated like another terminal. This means having a dedicated breaker for fault break duty. Furthermore, since the high-speed relay at the generating facility must be part of a relay scheme that communicates with other relays at remote terminals, the relays installed at the generating facility interface must be compatible with the relays at the remote ComEd substations. The only way to ensure the compatibility and coordination of parallel generation schemes is for ComEd to maintain ownership of the relaying at the generating facility substation.

The generation protection is as important as the transmission interface relaying for maintaining a stable and reliable flow of power. ComEd and NERC require redundancy of protective functions on generators connected to the transmission system such that any type of fault can be detected and cleared at least two ways. This can be accomplished by using a primary and a back-up relay function for all types of faults. NERC guidelines state that no single relay failure should cause the generator to fail to trip for a fault condition. For this reason, ComEd requires two independent lockout relays for tripping for electrical fault conditions; one activated by primary relay functions and the other by back-up relay functions.

In addition to the specific relay functions listed in Appendix 5, adequate protection must be in place to address stability, load rejection and inadvertent energization. Along with the required protection scheme of the generation, the protection for these conditions must be described for review and approval by ComEd. The required generation protection must include at least all of the electrical fault functions specified by the ANSI/IEEE AC Generator Protection Guide C37.102-1993 for the type of generator installed.

Multiple Generating Installations on a Single ComEd Supply Line

Protection requirements for the addition of generation to a ComEd supply line with existing generation have to be made on a case by case basis. The possibility exists that under these circumstances an installation that might be considered a Plan A would require Plan B type protection and a Plan B may require Plan C type protection. The addition of generation to the supply line may require additional protection at the existing installation. As a general rule, the protection at the ComEd source station will be determined by the total generation on the line.